

# Population structure and distribution pattern of *Taxus cuspidata* in Muling region of Heilongjiang Province, China

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**Abstract:** An investigation was conducted on distribution pattern, site condition and population structure of yew *Taxus cuspidata* Sieb. et Zucc. in Muling Forest Bureau of Heilongjiang Province, China in April, 2005. Results showed that yew is mainly distributed under the main storey of natural mixed forest of conifer and broadleaf, the soil moisture content of the yew site is high (40%–60%), the pH value of soil is relatively lower (4.7–5.5), and that the population structure of wild yew is not rational, belonging to the degeneration population, which is one of the reasons leading to the population decline. Although the site conditions of Muling area are suitable for the growth of wild yew, the population of wild yew shows a decline tendency, due to the fact that the middle-sized adult yew trees have been cut, young yews are often grazed by wildlife, and that the trunks of adult yew tend to be hollow.

**Keywords:** *Taxus cuspidata* Sieb. et Zucc.; Yew; Population structure; Spatial distribution pattern; Site conditions

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## Introduction

*Taxus cuspidata* Sieb. et Zucc., so-called yew, is mainly distributed in Changbai Mountain and Xiaoxing'an Mountains of China. It is a perish tertiary relic species in Northeast China, and its natural population has been declining slowly due to sporadic distribution and human disturbance. As a result, yew has been listed in the first rank of National Protection Wild Species. Muling Forest Bureau of Heilongjiang Province is one of main producing areas of wild yew in China, and Muling Yew Nature Reserve has been set up as one of the natural protection areas of yew.

Yew lives dispersedly, grows slowly, like sciophilic and cold wet habitat, and its annual growth increment is relatively lower. Up to date, many studies have been carried out on yew species. They mostly focused on its tissue culture technique (Hao *et al.* 2004; Wang *et al.* 2002; Li 2001; Gao *et al.* 1994; Chen *et al.* 2000), the isolation and extraction of taxol, assay of taxol content (Yan *et al.* 1994; Russin *et al.* 1995; Yuan *et al.* 2002; Shi *et al.* 2003) and planting technique, etc. (Wu *et al.* 1996; Cui *et al.* 2003; Gao *et al.* 2003; Wen *et al.* 2003). Report on population ecology of yew, however, is less. In this study we analyzed the structural characters, distribution patterns and site conditions of yew and explore the reasons why yew tends to be endangered species, so as to provide significant reference for efficient protection and application of yew resources.

## Study area

This study is conducted in the Shuangning and the Toudaogou forest farms of Muling Forestry Bureau ( $N19^{\circ}50'44''06'$ ,  $E110^{\circ}38'130''04'$ ), Heilongjiang Province, China, and outside Nature Reserve of yew (Fig. 1). Eight compartments of

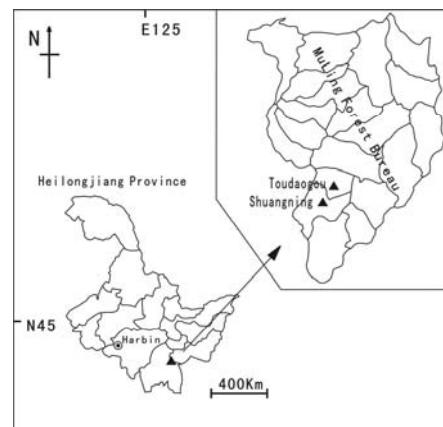
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Shuangning Forest Farm and Four compartments of the Toudaogou Forest Farm are chosen as study areas. The altitudes of study areas is in range of 680–731 m a.s.l.. Exposure is northeast, with a slope of about 15–45 degrees (average 18 degrees). The climate of Muling area is typical continent monsoon. The free-frost period is about 110 days, annual mean precipitation 440–510 mm, annual average temperature  $-2^{\circ}\text{C}$ , and the annual accumulated temperature above  $5^{\circ}\text{C}$  is 1 736.7 $^{\circ}\text{C}$ .



**Fig.1 Location of study area**

Yew is mainly distributed under the main storey of natural mixed forest of conifer and broadleaf on the upper and middle parts of the shady slope, with a canopy density of 0.6–0.7. The soil type is the mountainous dark brown forest soil. The main edificatos are *Abies nephrolepis* (Trautv.) Maxim., *Picea koraiensis* Nakai., *Abies holophylla* Maxim, and the main dominant species are *Pinus koraiensis* Sieb. Et Zucc, *Betula cosata* Trauty, *Acer mono* Maxim., *Tilia amurensis* Rupr., *Betula platyphylla* Suk., and the shrubs include *Corylus heterophylla* Fish. ex Trautv., *Equisetum hyemale* L., *Deyeuxia angustifolia* (Kom.) (Chang *et al.*).

## Methods

Three (male, female, and young) typical sample plots (20

$\text{m} \times 20 \text{ m}$ ) were separately set up in the sites in April, 2005. The distribution of yew and its company species were investigated (Fig. 2). The diameter at breast height, height, crown diameter

and number of yew trees were investigated (Fig. 3-5). The site conditions were determined using spectrum SC-900, spectrum TDR-300, IQ-150, spectrum watchdog, and other instruments.

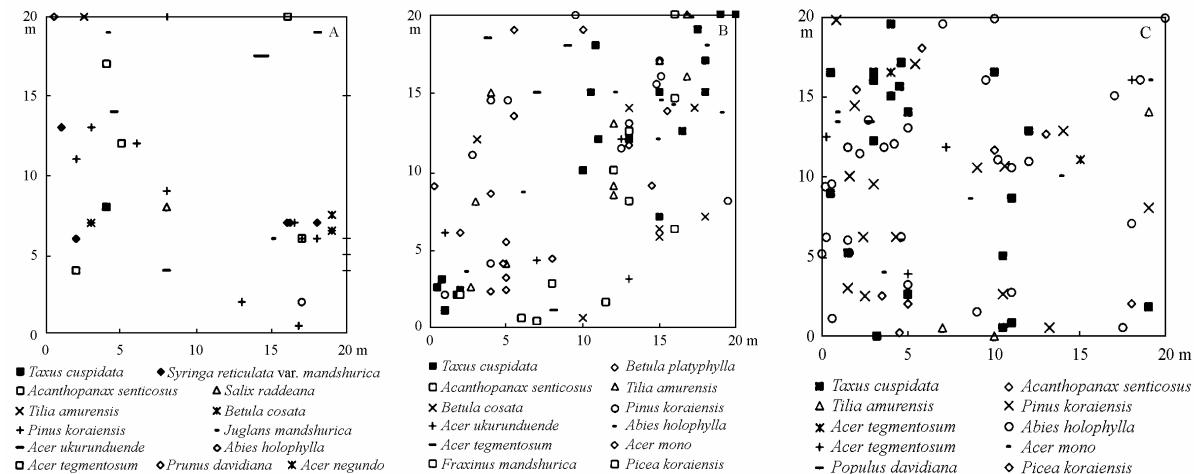


Fig.2 Distributions of male (A), female (B), young (C) *Taxus cuspidata* sites and their company species

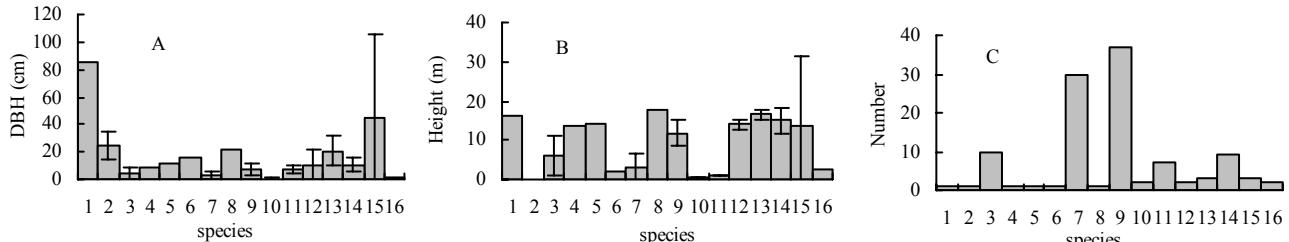


Fig.3 Average diameter at breast height (DBH) (A), height (B) and number (C) of male *Taxus cuspidata* sites and its company species

**Note:** The number of 1–16 along X axis represents *Taxus cuspidata*, *Syringa reticulata* var. *mandshurica*, *Acanthopanax senticosus*, *Salix raddeana*, *Tilia amurensis*, *Betula cosata*, *Pinus koraiensis*, *Juglans mandshurica*, *Acer ukurunduende*, *Abies holophylla*, *Acer tegmentosum*, *Acer mono*, *Prunus davidiana*, *Acer negundo*, *Picea koraiensis*, *Cosmos mandshurica*, respectively.

## Results and discussion

### Analysis of population structure of wild yew

In the male yew plot (Fig 2 A), only one bearing male yew was found. Its DBH was 84 cm (Fig 3A) and height was more than 15 m (Fig 3B) over the second main storey. Except for very few companions and shrubs, no any young tree and seedling of yew were found. The result means that yew reproduction by seeds mainly (Zhou et al. 2004). In the female yew plot (Fig 2 B), there were many female yews accompanying with higher edificato and dominant species. The DBH of female yew was in range from 40 cm to 60 cm (Fig 4A) and the average height was about 15 m (Fig 4B). The crown of female yew was larger than those of other species (Fig 4C). Of these female yew trees, only 3 trees were adult, the rests were the young trees (Fig.4D). This investigation result indicates that the seeds of the bearing female yew have strong propagating ability, which helps to maintain the population stability of yew. In the young yew plot (Fig 2 C), the young trees of yew and their companions presented an uniformity distribution. Eighteen young trees and seedling of yew were surveyed (Fig. 5), accounting for 30% of the total tree number in the plot, and they mainly distributed in the shade environment. Shade environment can promote growth of young yew

### Analysis of site condition of wild yew

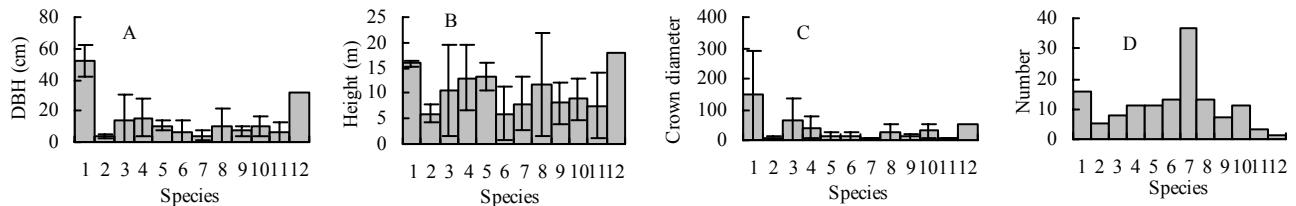
Muling Forest Bureau is a centralized distribution area of wild

yew, and the site condition here is suitable to the cutting propagation of yew. To explore more suitable site of yew propagation, we surveyed the soil conditions of male, female and young yew sites. Results showed that the soil moisture contents of the three yew sites were relative high (Table 1), 61.4% for male sample site, 43.6% for female site, and 47.3% for young yew site, belonging to the typical moist soil. Thus, we infer that during the spring, the moist habitat is beneficial to the cutting of yew.

The pH measurement showed that the soils of the three sample sites tend to be acidic, in range of 4–6. The acidic soil of yew sites may attribute to the distribution of the conifer species. The soil density was obviously different in different depths of the sample sites. The surface soil in the female sample site was floppy and rather thick (about 5 cm) and that of the male yew sample site was about 2.5 cm. Comparatively, the soil of the young yew sample site was solid (Table 1). Hence, according to the distribution and the number of yew, we can conclude that the soil with higher moisture and acidity is suitable for growth of yew.

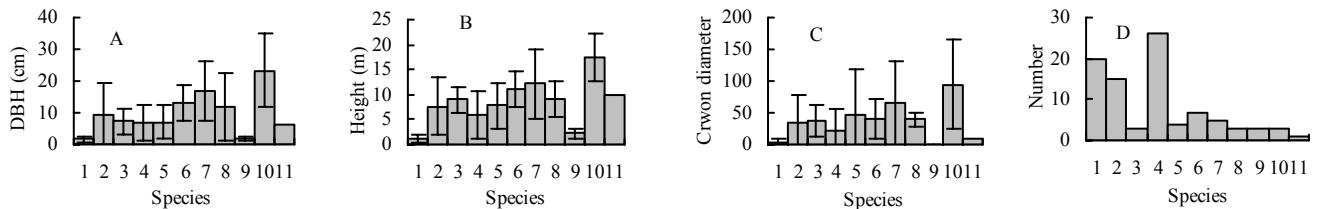
Table 1. Analysis of suitable site of *T. cuspidata*

Plots	Soil water content (%)	pH value	Soil density (kPa)				
			0 cm	2.5 cm	5 cm	7.5 cm	10 cm
Male	61.4	5.51	0	0	35	421	1193
Female	43.6	4.81	0	0	0	702	1123
Young	47.3	4.70	0	491	2563	2703	2387



**Fig.4 Average DBH (A), height (B), crown diameter (C) and number (D) of female *Taxus cuspidata* sites and its company species**

Note: The number of 1–12 along X axis represents *Taxus cuspidata*, *Betula platyphylla*, *Picea koraiensis*, *Tilia amurensis*, *Betula cosata*, *Pinus koraiensis*, *Acer ukurunduende*, *Abies holophylla*, *Acer tegmentosum*, *Acer mono*, *Fraxinus mandshurica*, *Ulmus pumila*, respectively.



**Fig.5 Average DBH (A), height (B), crown diameter (C) and number (D) of young *Taxus cuspidate* site and its company species**

Note: The number of 1–11 along X axis represents *Taxus cuspidata*, *Pinus koraiensis*, *Acer ukurunduende*, *Abies holophylla*, *Acer tegmentosum*, *Acer mono*, *Picea koraiensis*, *Tilia amurensis*, *Acanthopanax senticosus*, *Tilia mandschurica*, *populus davidiana*, respectively.

### Analysis of population age-structure of yew

The average DBH of the adult yews in the sample sites was more than 50 cm and the average height was above 15 m. The number of adult yew was quite less, meantime, the trunks of the aged trees were often hollow. DBH of young yew was less than 5 cm, and the height was below 3 m, but the number was more (at least 20 plants) (Fig. 5). The branches of the young yew were often gnawed by wildlife, which also affected the growth of the young trees. Yew was not the main body in main storey of stand and did not distribute in succession layer. Only young yews had a group distribution in regeneration layer. Such a distribution pattern of yew indicated that population structure is one of reasons leading to its population decline. In our investigation, no yew individual with a DBH from 5 cm to 50 cm was found. This is mainly due to excess felling and serious damage by human. The investigation results showed that the population structure of wild yew is not rational, belonging to the degeneration population. Therefore, much attention should be paid to promoting the development of yew population.

### Conclusions

In Muling area, wild yew is the rare tree species in natural mixed forest of conifer and broadleaf. Although the site conditions here are suitable for the growth of wild yew, the trunks of adult yew tend to be hollow, the middle-sized adult trees had been cut, and the young trees were often gnawed by wildlife. Hence, the population of the wild yew in this area had a tendency of decline. The yew resources of this area should be further protected.

### References

- Bai Guangxin, Wu Banghua. 2002. Research in China's *Taxus cuspidata* [M]. Beijing: China Forestry Publishing House, p259. (in Chinese)
- Begon, M., Mortimer, M. 1981. Population ecology: an unified study of animals and plants [M]. London: Blackwell Scientific Publication, p10–28.
- Cai Fei. 2000. A study on the structure and dynamics of *Cyclobalnopsis glauca* population at hills around West Lake in Hangzhou [J]. Scientia Silvae Sinicae, **36**(3): 67–72. (in Chinese)
- Chen Yongqin, Zhu Weihua, Wu Yunqi. 2000. Effects of culture conditions on callus growth and taxol formation of *Taxus yunnanensis* Cheng et L. K. Fu [J]. China Journal of Chinese Materia Medica, **25**(5): 269–272. (in Chinese)
- Cui Chengwan, An Fengyun, Liu Xifa. 1996. Temperature influence on seed sprouting of *Taxus cuspidata* [J]. Chinese Traditional Medicine Magazine, **21**: 20–22. (in Chinese)
- Gao Shanlin, Tower G.H.N. 1994. Establishment and optimization of cell culture of *Taxus* Sp. [J]. Journal of China Pharmaceutical University, **25**(6): 321–324. (in Chinese)
- Gao Zhaowei, Wang Tingliang, Zou Gaoshun, et al. 2003. Study on distribution, habitat and cultivation technique of *Taxus wallichiana* var. *mairei* in Fujian Province [J]. East China Forest Management, **17**: 6–13. (in Chinese)
- Hao Rentaben, Zhao Ying. 2004. Tissue culture of *Taxus cuspidata*[J]. Inner Mongolia Forestry Science & Technology, **3**: 11–13. (in Chinese)
- Harper, J.L. 1977. Population biology of plants [M]. New York: Academic Press.
- Li Bolin. 2001. Studies on taxol formation in taxus cell cultures [J]. Journal of Guangxi Normal University, **19**(2): 84–87. (in Chinese)
- Liu Feng, Chen Weilie, He Jinsheng. 2000. Population structure and regeneration of *Quercus aliena* var. *acuteserrata* in Shennongjia [J]. Acta Phytocologica Sinica, **24**(4): 396–401. (in Chinese)
- Mei Xingguo, Wu Qijun, Jiang Zhenran, et al. 2002. Regulation of taxol biosynthesis in cell suspension culture of *Taxus cuspidata* [J]. Life Science Research, **6**: 152–155. (in Chinese)
- Qiu Shuping, Liu Zhongling. 1994. Chinese rare and endangered plants [M]. Shanghai: Shanghai Science and Education Press, p55–57. (in Chinese)
- Wang Senlin, Hu Fengqing. 2002. Study on callus culture of *Taxus cuspidata* [J]. Journal of Liaoning University, **1**: 75–77. (in Chinese)
- Wang Bing, Zheng Hongyue. 1998. Identifying of yew (*Taxus cuspidata*) crude drug [J]. Journal of Traditional Chinese Medicine, **29**: 267–269. (in Chinese)
- Weng Zhiyuan, Wu Guangliu. 2003. Cultivation technique of *Taxus wallichiana* var. *mairei* in Taishun [J]. Journal of Zhejiang Forestry Science & Technology, **23**: 3–41. (in Chinese)
- Wu Banghua, Zhang Qichang, Li Dezhi. 1996. Study on growth and management of *Taxus cuspidata* [J]. Journal of Jilin Forestry University, **12**: 125–129. (in Chinese)
- Zhou Zhiqiang, Liu Tong, Yuan Jilian. 2004. Population characteristics of yew (*Taxus cuspidata*) in the Muling Yew Nature Reserve, Heilongjiang Province [J]. Acta Phytocologica Sinica, **28**(4): 476–482. (in Chinese)